DEPARTEMEN SISTEM INFORMASI
Fak. Teknologi Elektro & Informatika Cerdas

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DATABASE SYSTEMS

Chapter 01
Introduction

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Learning Objectives & Book Reading

- **Learning Objectives:** To understand database concepts and some related terminology, database models, and database life cycle
- **Book reading:** Hoffer, Chapter 1

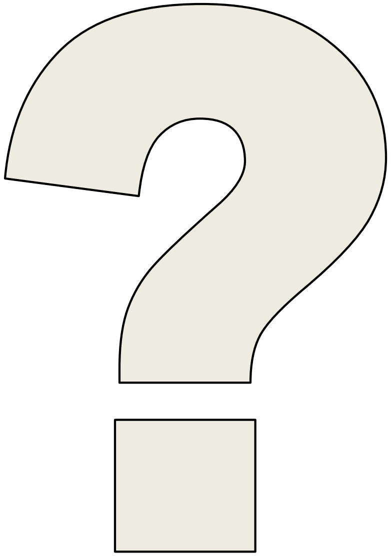
Overview

- Database Concepts and Terminology
- Database Models
- Database Life Cycle

Overview

- What’s a database?
- What’s a DataBase Management System?
- Why use a database & DBMS?
- How can you use a DBMS?

What is a Database?



How many have used a database today?

What is a database?

- Broadly speaking – any collection of data might be called a database
- Normally, though, certain characteristics of the data and how it is stored distinguish a database from any random or adhoc collection of data

What is a database?

- Wikipedia tells us:
  - “A database is an organized collection of data. The data is typically organized to model relevant aspects of reality (for example, the availability of rooms in hotels), in a way that supports processes requiring this information (for example, finding a hotel with vacancies).”

What is a Database?

- *A Database is a collection of stored operational data used by the application systems of some particular enterprise*. (C.J. Date)
  - Paper “Databases”
    - Still contain a large portion of the world’s knowledge
      - Changing as, for example, book scanning projects like Google Books and the Open Content Alliance convert paper docs
  - File-Based Data Processing Systems
    - Early batch processing of (primarily) business data
      - Still with us – in fact the entire Hadoop MapReduce suite used in Big Data processing is primarily file-based
  - Database Management Systems (DBMS)
    - Some old ones still in use, but most modern DBMS are relational, object or object-relational, but there is increasing use of so-called “noSQL” key/object databases

What is a DataBase Management System?

- Wikipedia again:
  - “A general-purpose database management system (DBMS) is a software system designed to allow the definition, creation, querying, update, and administration of databases.
  - Well-known DBMSs include MySQL, PostgreSQL, SQLite, Microsoft SQL Server, Microsoft Access, Oracle, Sybase, dBASE, FoxPro, and IBM DB2.”

What’s a DBMS

- It maintains **Metadata** about the database
  - Data about data
    - In DBMS this means all of the characteristics describing the attributes of an entity, E.G.:
      - name of attributes
      - data type of attributes
      - size of the attributes
      - format or special characteristics
  - Characteristics of tables or ‘relations’
    - Name, content, notes, etc.
    - Associated elements in other tables

Why Databases and DBMS

- In programming courses you have learned about data and file structures and how they can be used in your programs to help you accomplish various goals
- Let’s say you want to create a program to keep a list of names and addresses
  - How would you write a program to do it?
  - Suppose the list got REALLY big – what kind of file structures might you use in searching it?

Why Use a DBMS?

- History
  - 50’s and 60’s all applications were custom built for particular needs
  - File based
  - Many similar/duplicative applications dealing with collections of business data
  - Early DBMS were extensions of programming languages
  - 1970 - E.F. Codd and the Relational Model
  - 1979 - Ashton-Tate & first Microcomputer DBMS

From File Systems to DBMS

- Problems with File Processing systems
  - Inconsistent Data
  - Inflexibility
  - Limited Data Sharing
  - Poor enforcement of standards
  - Excessive program maintenance

DBMS Benefits

- Minimal Data Redundancy
- Consistency of Data
- Integration of Data
- Sharing of Data
- Ease of Application Development
- Uniform Security, Privacy, and Integrity Controls
- Data Accessibility and Responsiveness
- Data Independence
- Reduced Program Maintenance

Why use a DBMS?

- You don’t need to write all the code to manage your data
- It will gracefully scale to VERY large collections of data
- It will support transactions that are
  - Atomic (all or nothing)
  - Consistent (from valid state to valid state)
  - Isolated (no interference from concurrent use)
  - Durable (once committed is part of DB)
- Easy to port data to other DBMS or files

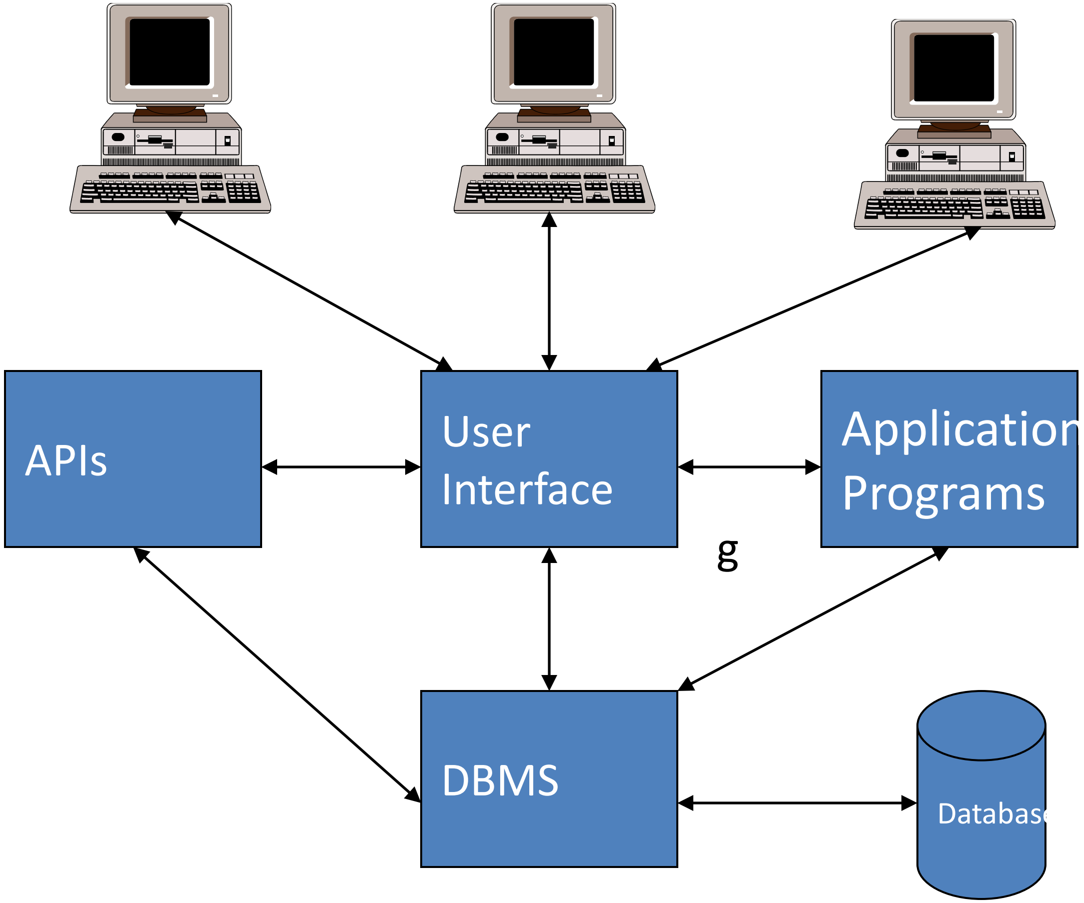
Terms and Concepts

- Database activities:
  - ***Create***
    - Add new data to the database
  - ***Read***
    - Read current data from the database
  - ***Update***
    - Update or modify current database data
  - ***Delete***
    - Remove current data from the database

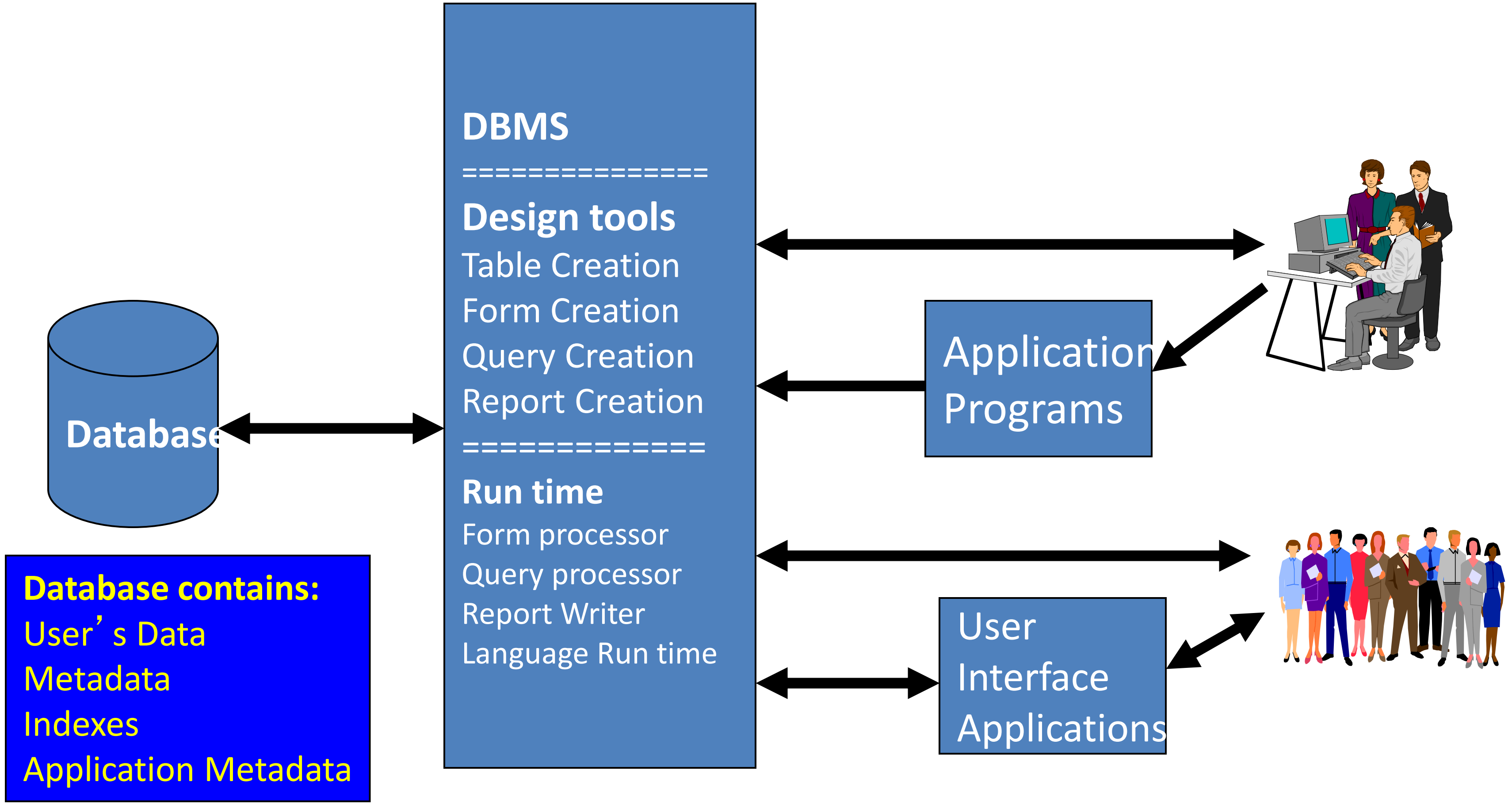
Terms and Concepts

- ***Data Independence***
  - Physical representation and location of data and the use of that data are separated
    - The application doesnt need to know how or where the database has stored the data, but just how to ask for it.
    - Moving a database from one DBMS to another should not have a material effect on application programs
    - Recoding, adding fields, etc. in the database should not affect applications

Database Environment



Database Components



Database

DBMS

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Design tools

Table Creation

Form Creation

Query Creation

Report Creation

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Run time

Form processor

Query processor

Report Writer

Language Run time

Application Programs

User Interface Applications

Database contains:

User’s Data

Metadata

Indexes

Application Metadata

Types of Database Systems

- Local Databases
- Centralized Database
- Client/Server Databases
- Distributed Databases
- Cloud-Based Databases

Local Databases

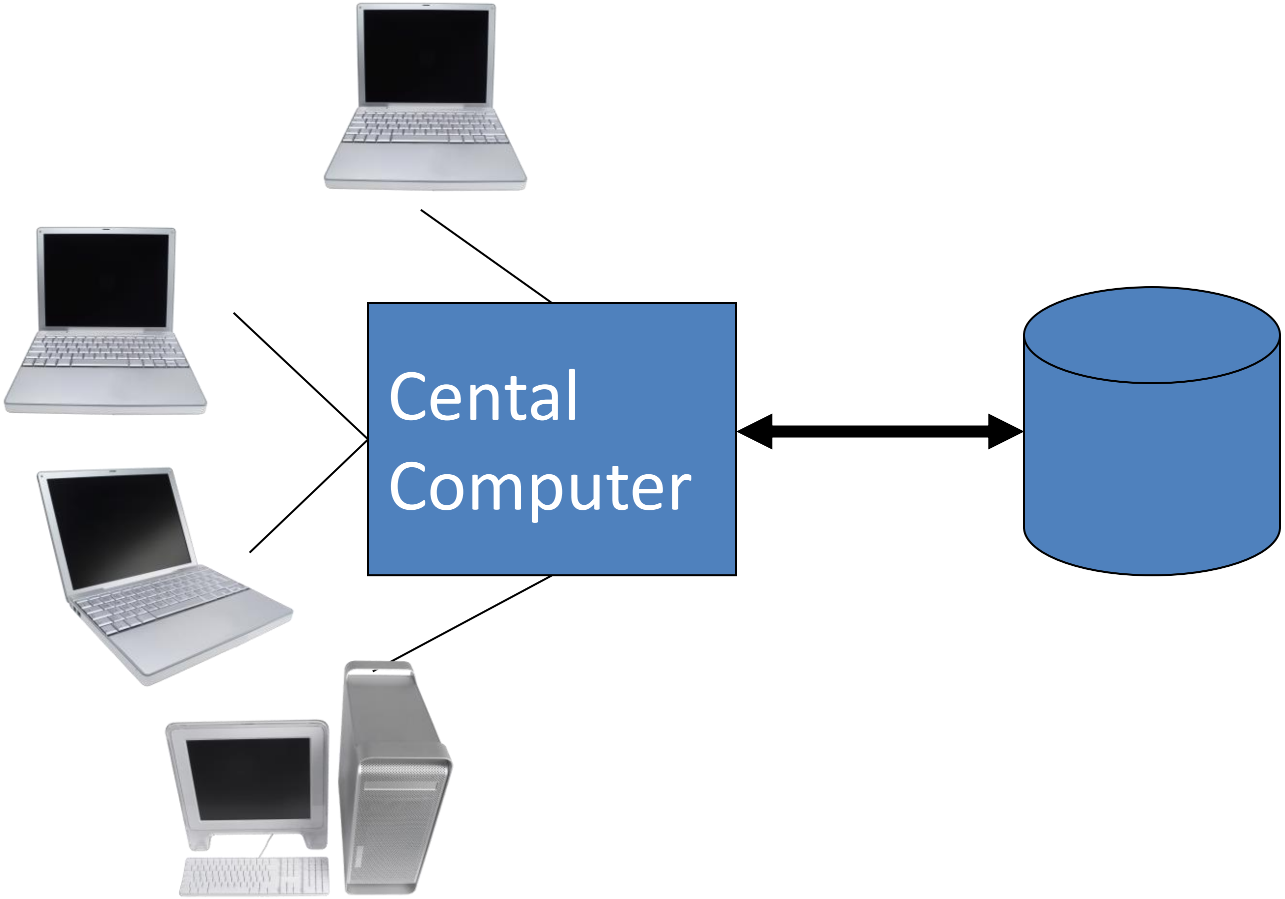
E.G.,

Access

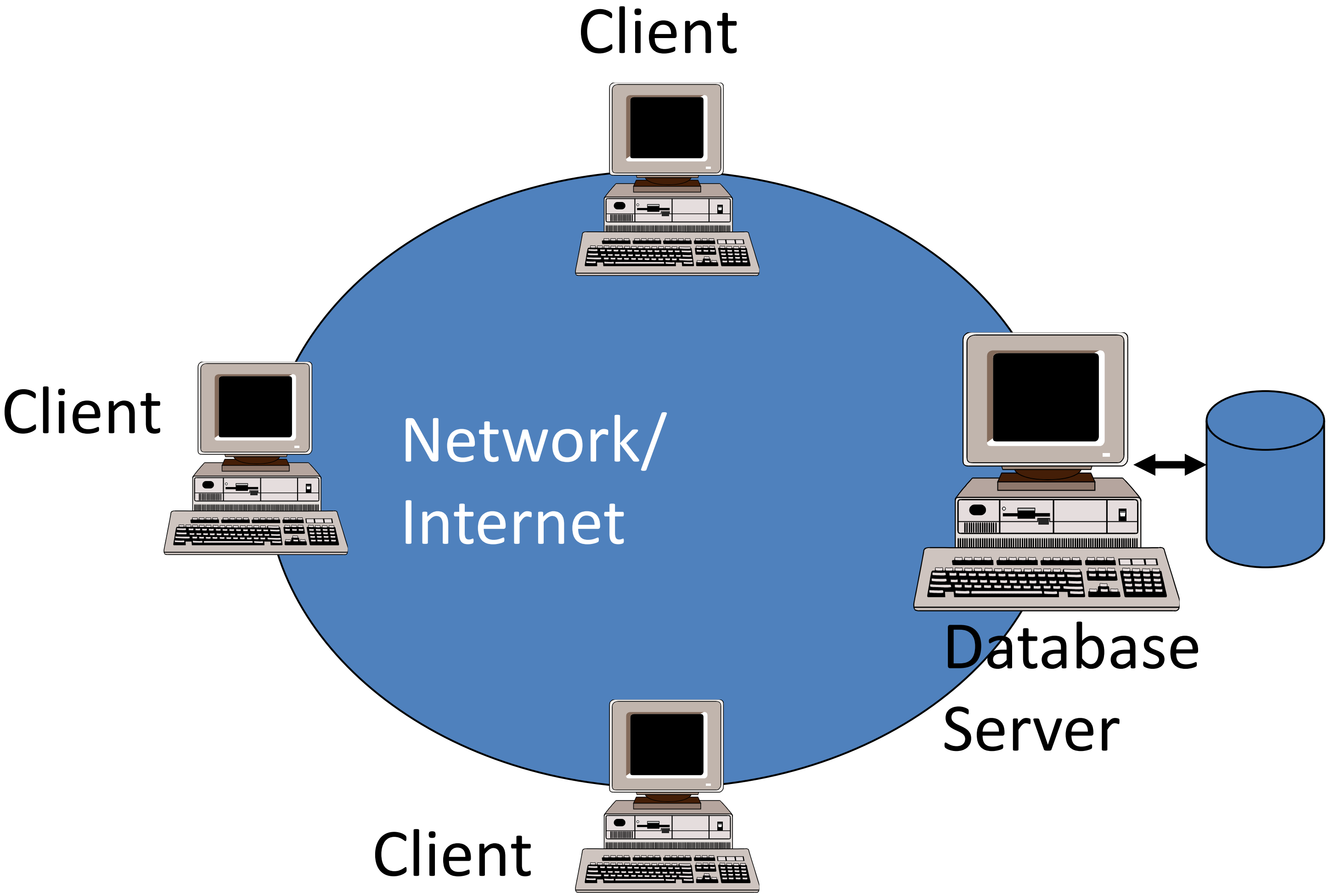
SQLite

Etc.

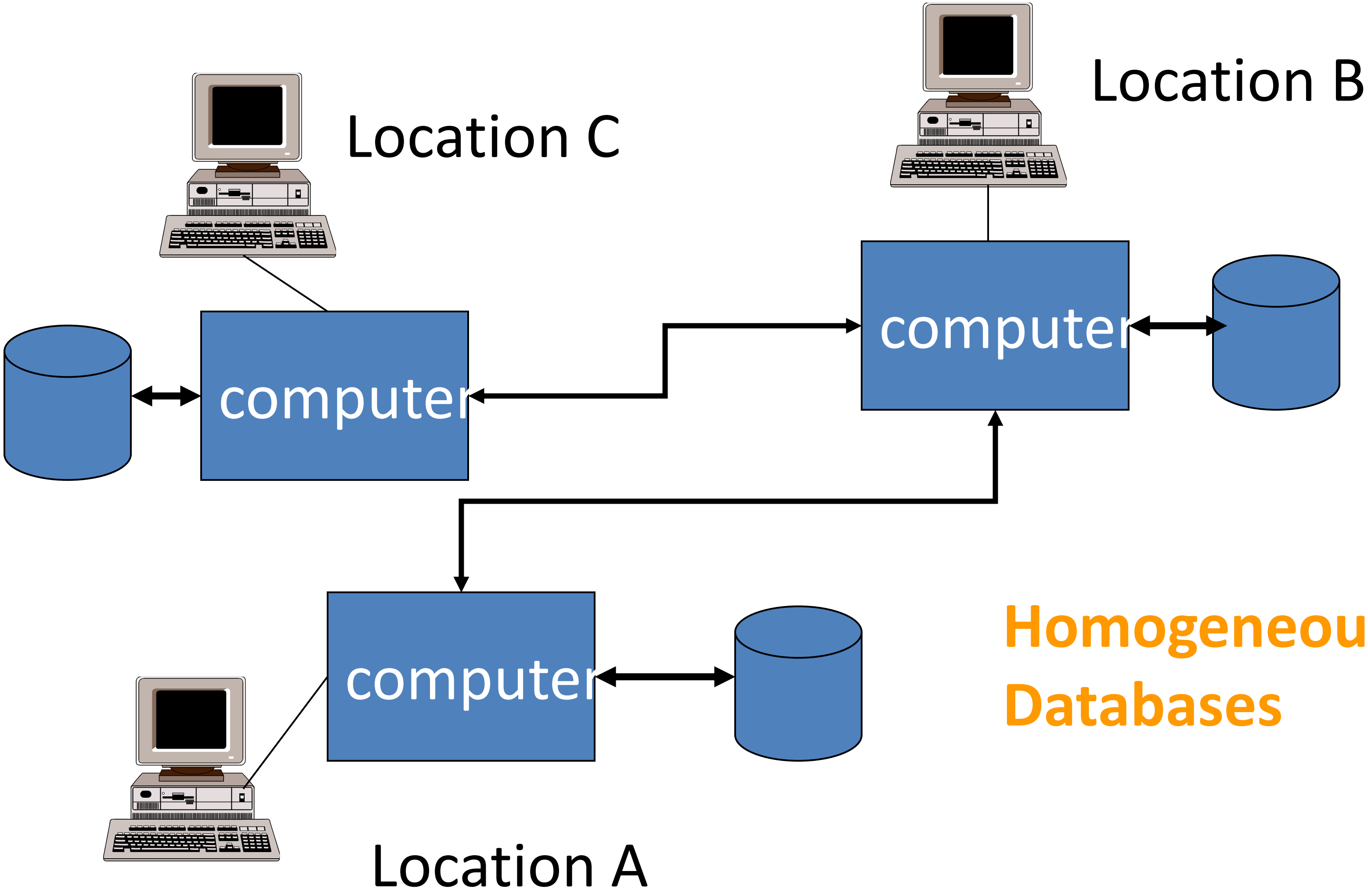
Centralized Databases



Client Server Databases



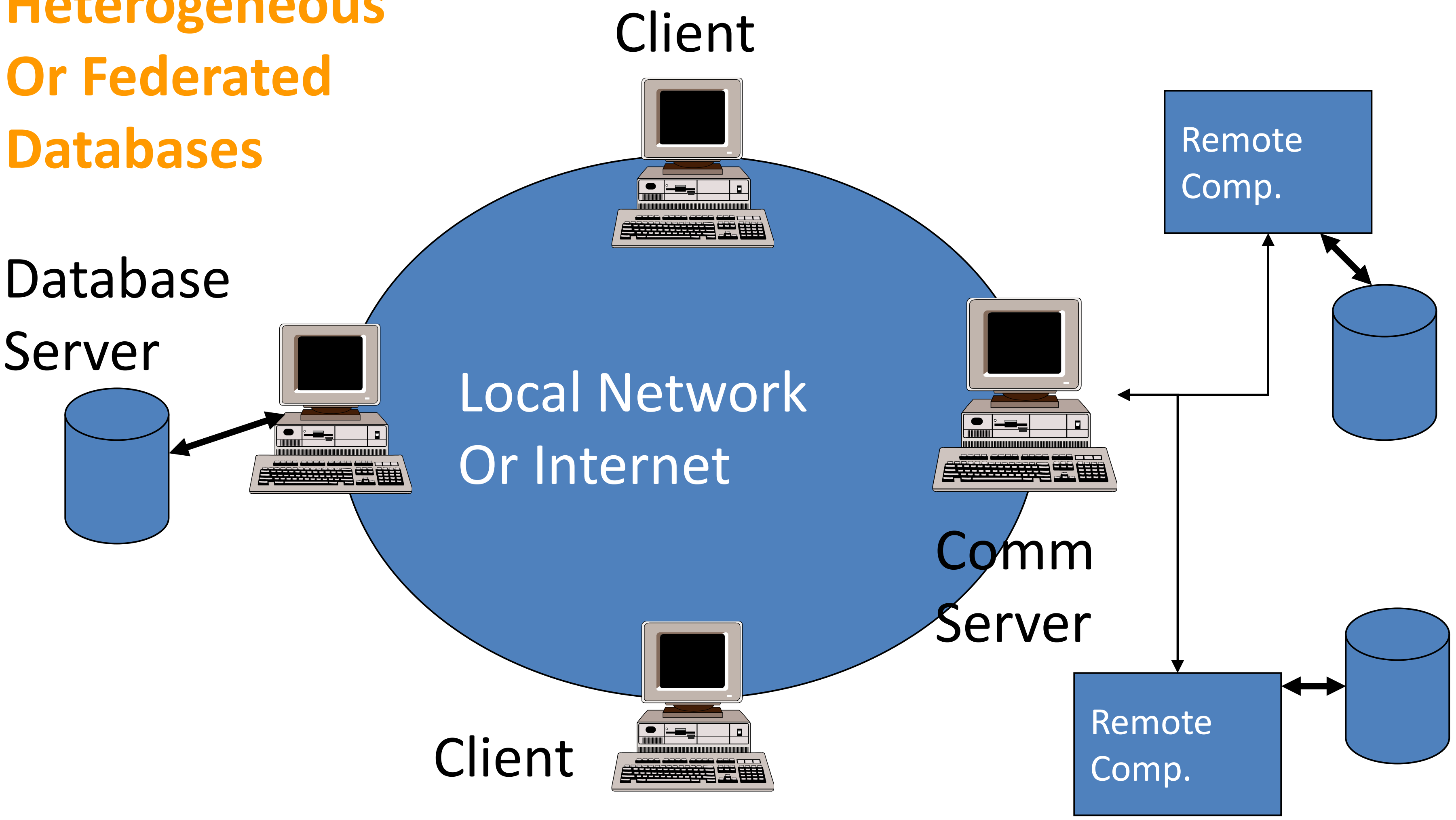
Distributed Databases



Homogeneous Databases

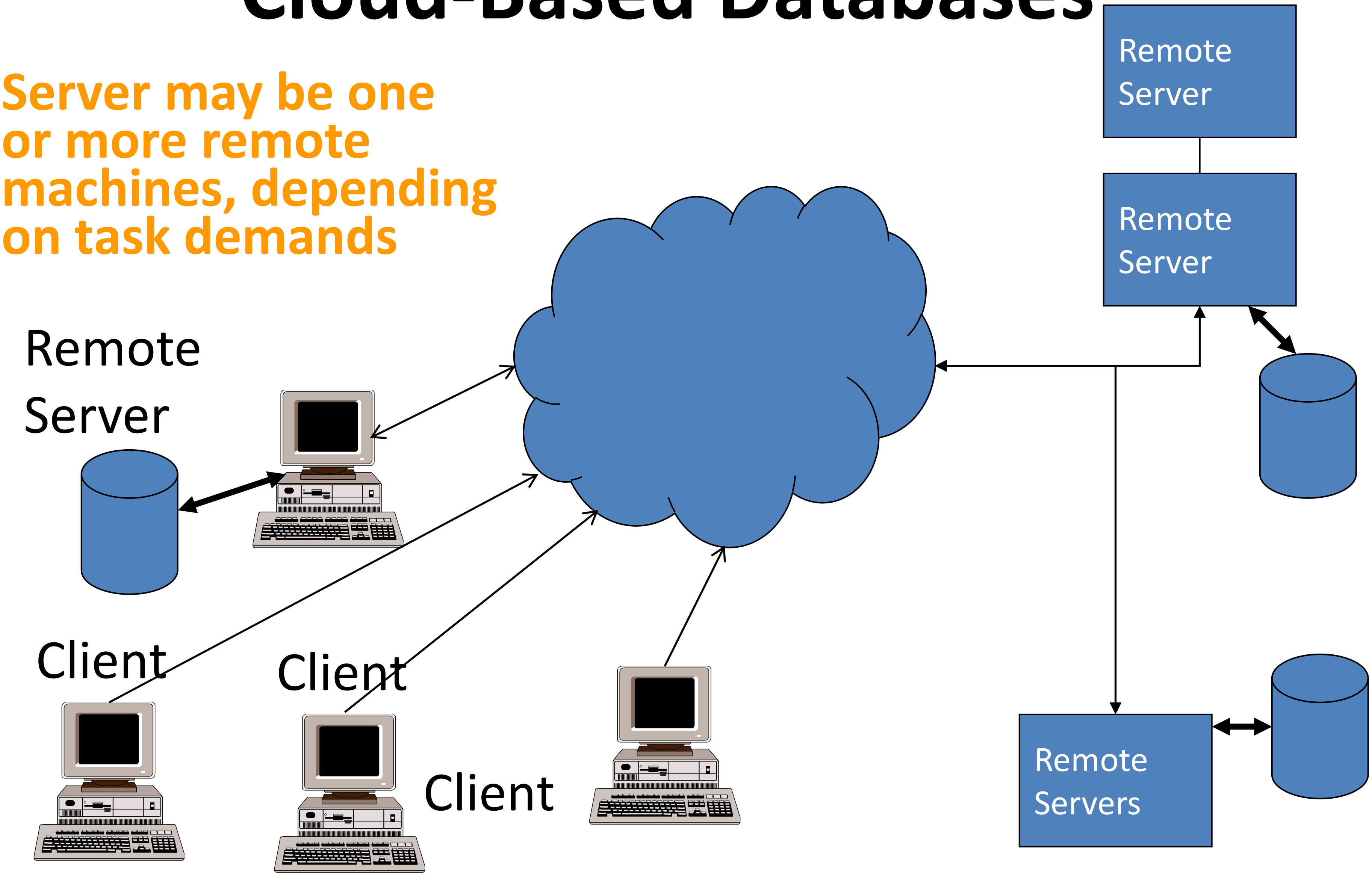
Distributed Databases

Heterogeneous Or Federated Databases



Cloud-Based Databases

Server may be one or more remote machines, depending on task demands



Range of Database Applications

- Local databases
  - Usually for individual user applications
    - E.g. SQLite is used by many iPhone Apps including IOS itself
- WorkGroup databases
  - Small group use where everyone has access to the database over a LAN (or internet)
- Departmental databases
  - Larger than a workgroup – but similar
- Enterprise databases
  - For the entire organization over an intranet or the internet

Terms and Concepts

- ***Database Application***
  - An application program (or set of related programs) that is used to perform a series of database activities:
    - Create
    - Read
    - Update/Modify
    - Delete
  - On behalf of database users

Terms and Concepts

- ***Enterprise***
  - Organization
- ***Entity***
  - Person, Place, Thing, Event, Concept...
- ***Attributes***
  - Data elements (facts) about some entity
  - Also sometimes called fields or items or domains
- ***Data values***
  - instances of a particular attribute for a particular entity

Terms and Concepts

- ***Records***
  - – The set of values for all attributes of a particular entity
  - – AKA “tuples” or “rows” in relational DBMS
- ***File***
  - – Collection of records
  - – AKA “Relation” or “Table” in relational DBMS

Terms and Concepts

- ***Key***
  - an attribute or set of attributes used to identify or locate rows in a table
- ***Primary Key***
  - an attribute or set of attributes that ***uniquely*** identifies each row in a table

Terms and Concepts

- *DA*
  - Data adminstrator - person responsible for the Data Administration function in an organization
  - Sometimes may be the CIO -- Chief Information Officer
- *DBA*
  - Database Administrator - person responsible for the Database Administration Function

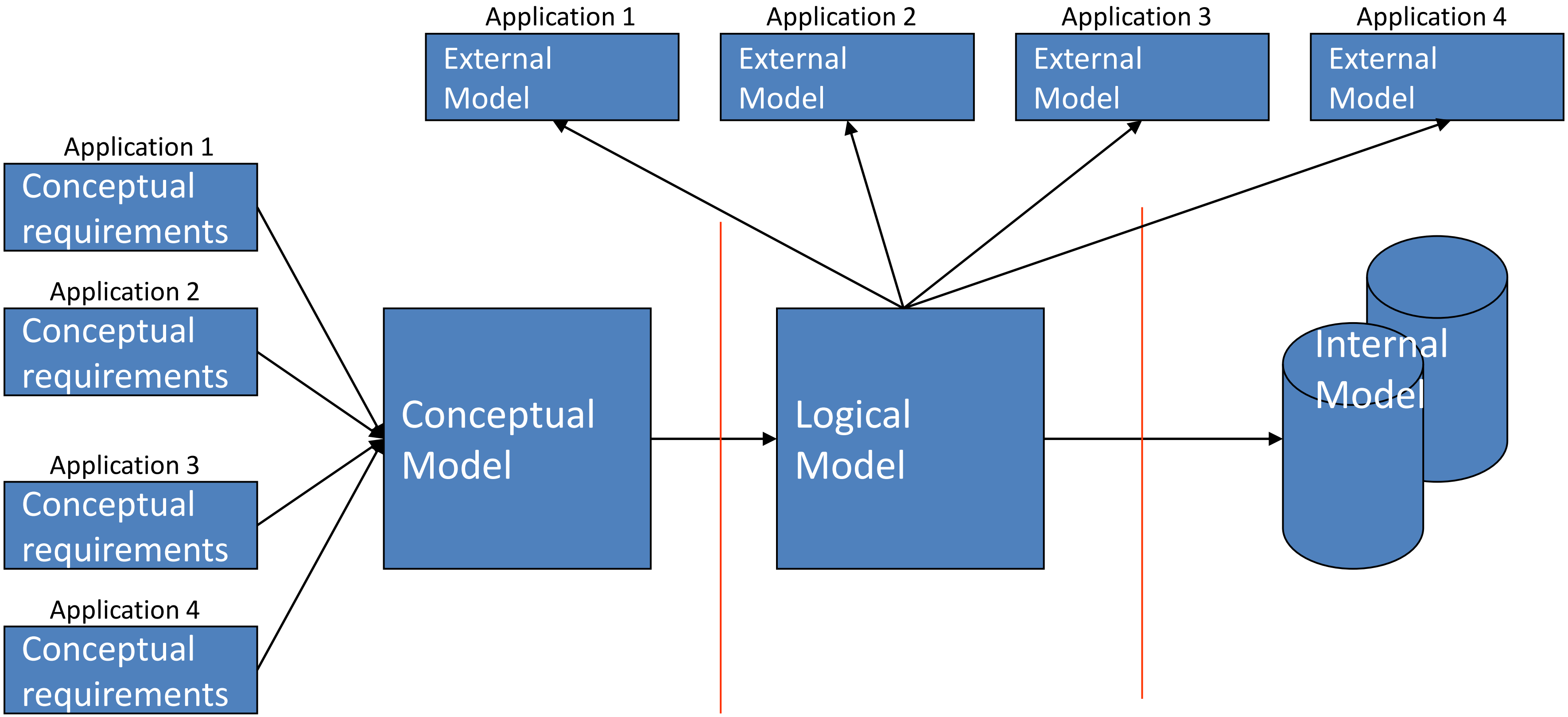
Terms and Concepts

- ***Models***
  - (1) Levels or views of the Database
    - Conceptual, logical, physical
  - (2) DBMS types
    - Hierarchical, Network, Relational , Object-Oriented, Object-Relational

Overview

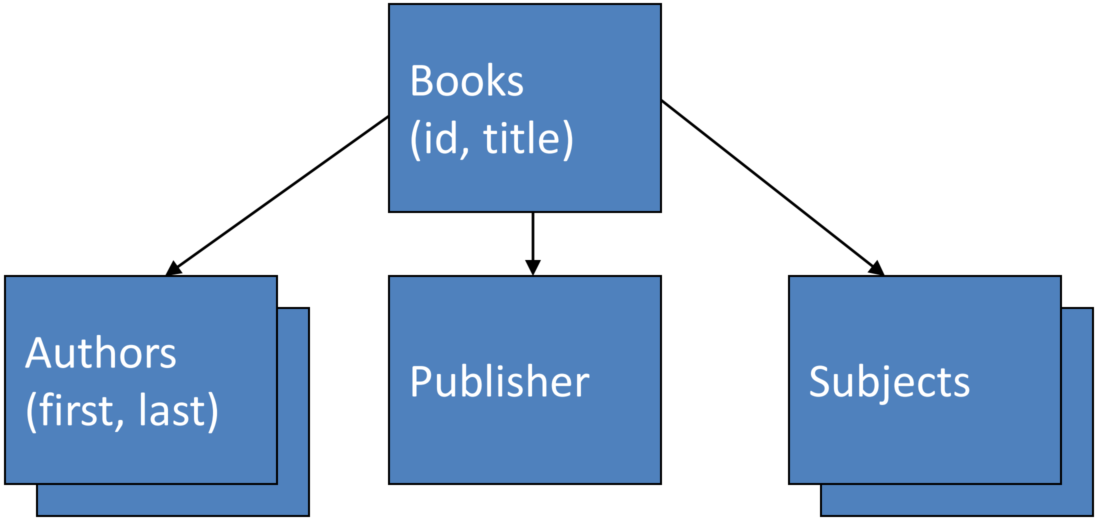
- Database Concepts and Terminology
- Database Models
- Database Life Cycle

Models (1)


Application 1
External Model
Application 2
External Model
Application 3
External Model
Application 4
External Model
Application 1
Conceptual requirements
Application 2
Conceptual requirements
Application 3
Conceptual requirements
Application 4
Conceptual requirements
Conceptual Model
Logical Model
Internal Model

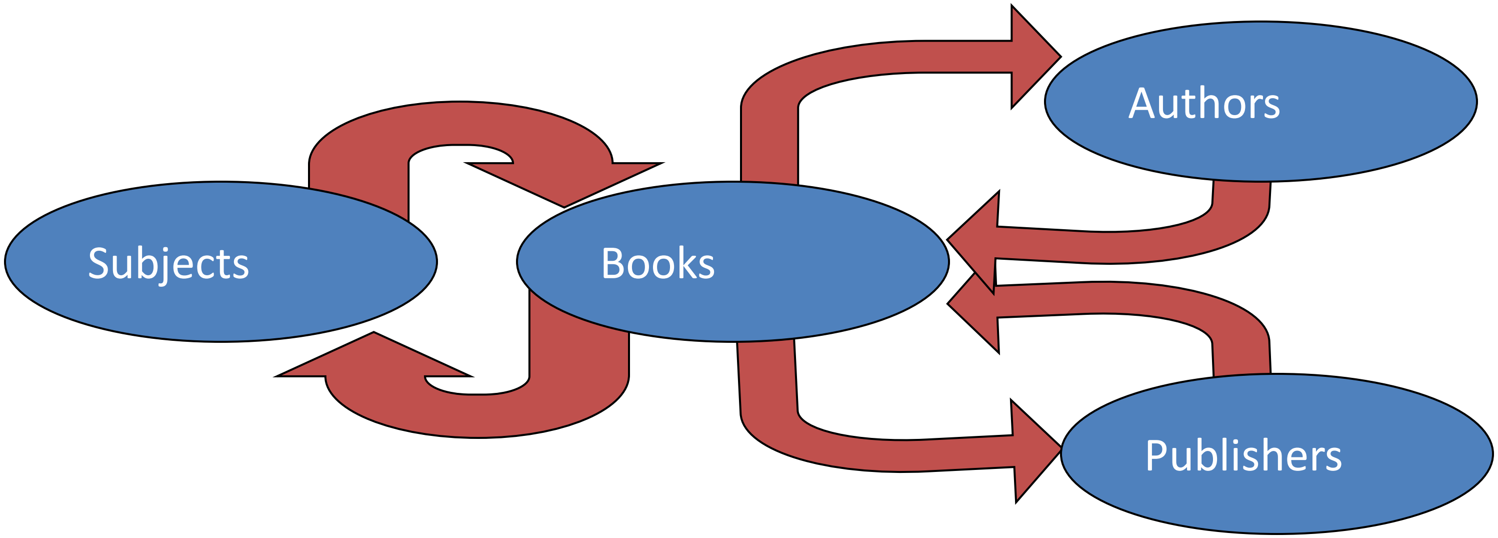
Data Models(2): History

- Hierarchical Model (1960’s and 1970’s)
  - – Similar to data structures in programming languages.



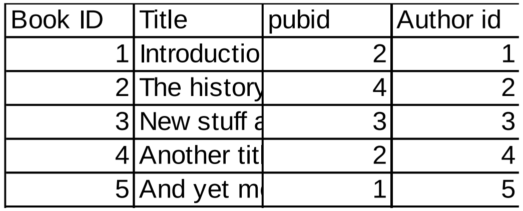
Data Models(2): History

- Network Model (1970’s)
  - Provides for single entries of data and navigational “links” through chains of data.

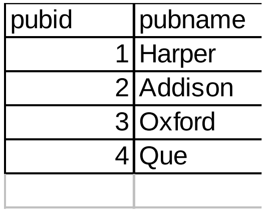


Data Models(2): History

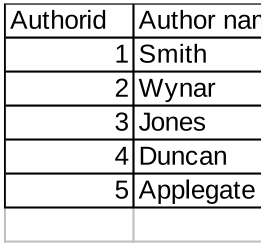
- Relational Model (1980’s)
  - Provides a conceptually simple model for data as relations (typically considered “tables”) with all data visible.



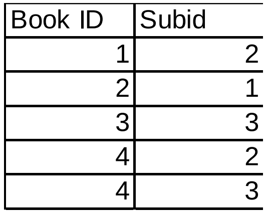
Book ID	Title	pubid	Author id
1	Introductio	2	1
2	The history	4	2
3	New stuff a	3	3
4	Another tit	2	4
5	And yet m	1	5



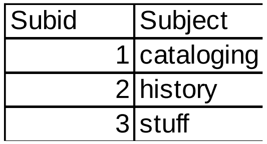
pubid	pubname
1	Harper
2	Addison
3	Oxford
4	Que



Authorid	Author nar
1	Smith
2	Wynar
3	Jones
4	Duncan
5	Applegate



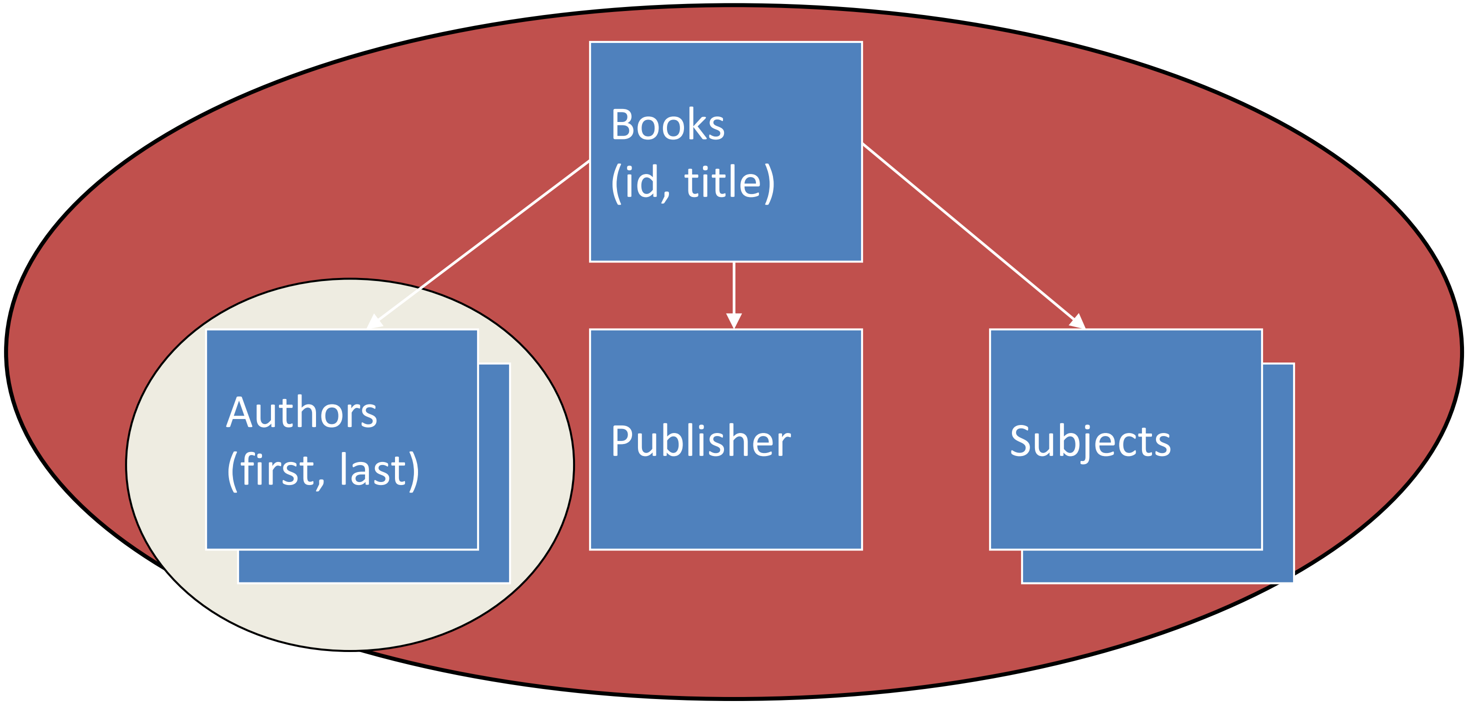
Book ID	Subid
1	2
2	1
3	3
4	2
4	3



Subid	Subject
1	cataloging
2	history
3	stuff

Data Models(2): History

- Object Oriented Data Model (1990’s)
  - Encapsulates data and operations as “Objects”



Data Models(2): History

- Object-Relational Model (1990’s)
  - Combines the well-known properties of the Relational Model with such OO features as:
    - User-defined datatypes
    - User-defined functions
    - Inheritance and sub-classing

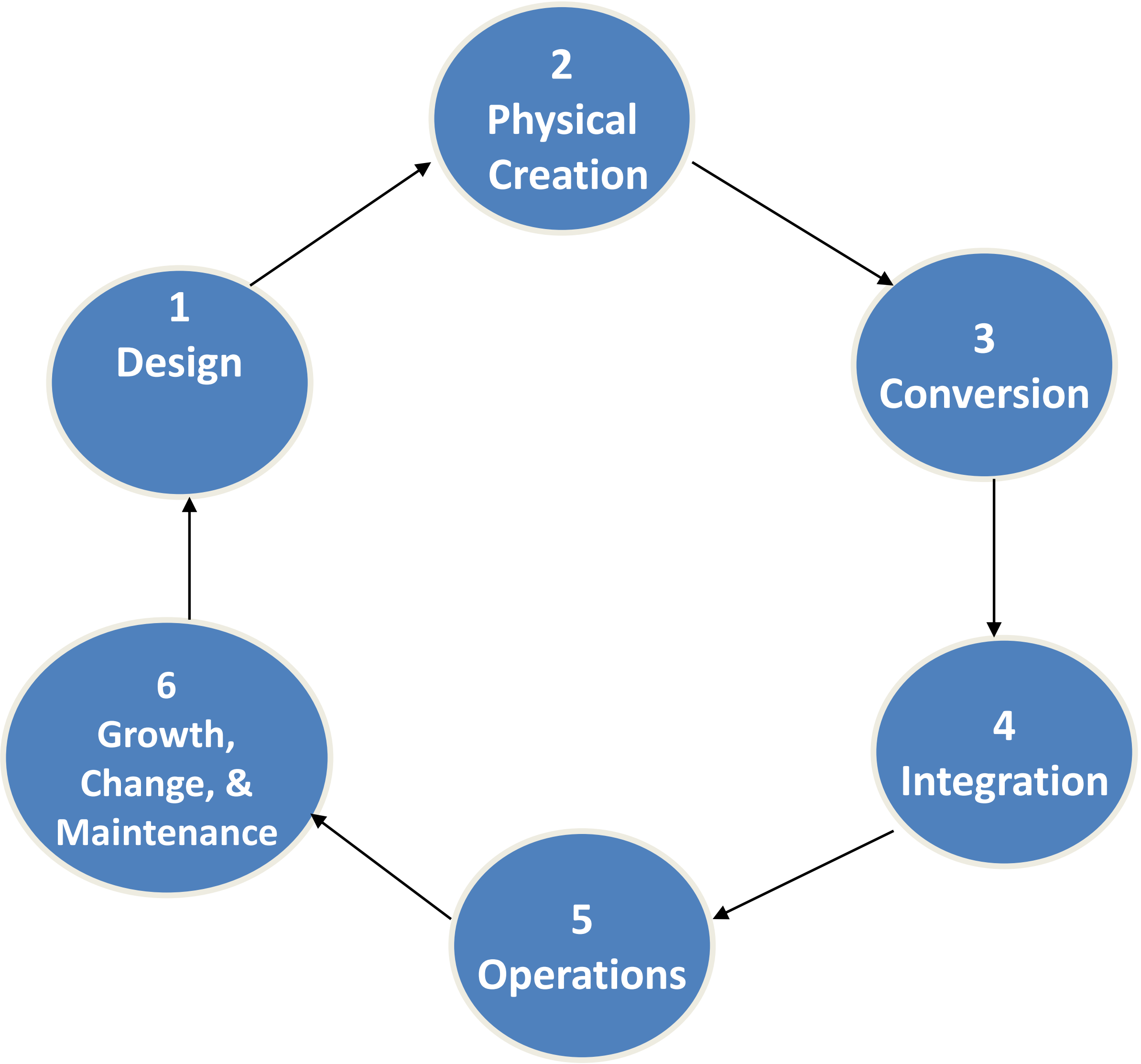
NoSQL Databases

- Started as a reaction to the overhead in more conventional SQL DBMS
- Usually very simple key/value search operations
- Usually very fast, with low storage overhead, but often lack security, consistency, and other features of RDBMS
- May use distributed parallel processing (grid/cloud, e.g. MongoDB + Hadoop)

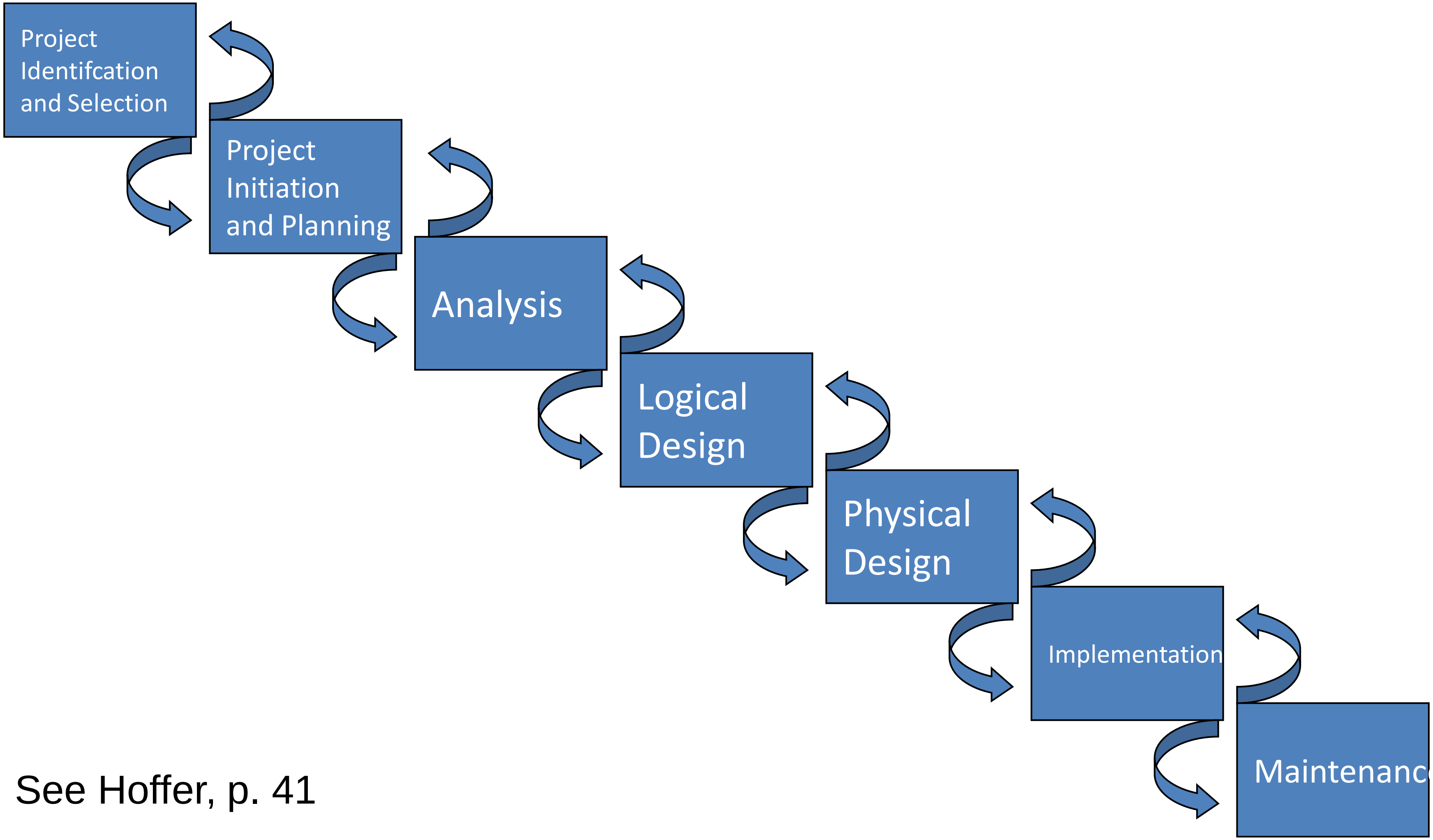
Overview

- Database Concepts and Terminology
- Database Models
- Database Life Cycle

Database System Life Cycle



The “Cascade” View



Project Identifcation and Selection

Project Initiation and Planning

Analysis

Logical Design

Physical Design

Implementation

Maintenanc

See Hoffer, p. 41

Design

- Determination of the needs of the organization
- Development of the Conceptual Model of the database
  - Typically using Entity-Relationship diagramming techniques
- Construction of a Data Dictionary
- Development of the Logical Model

Physical Creation

- Development of the Physical Model of the Database
  - data formats and types
  - determination of indexes, etc.
- Load a prototype database and test
- Determine and implement security, privacy and access controls
- Determine and implement integrity constraints

Conversion

- Convert existing data sets and applications to use the new database
  - May need programs, conversion utilities to convert old data to new formats.

Integration

- Overlaps with Phase 3
- Integration of converted applications and new applications into the new database

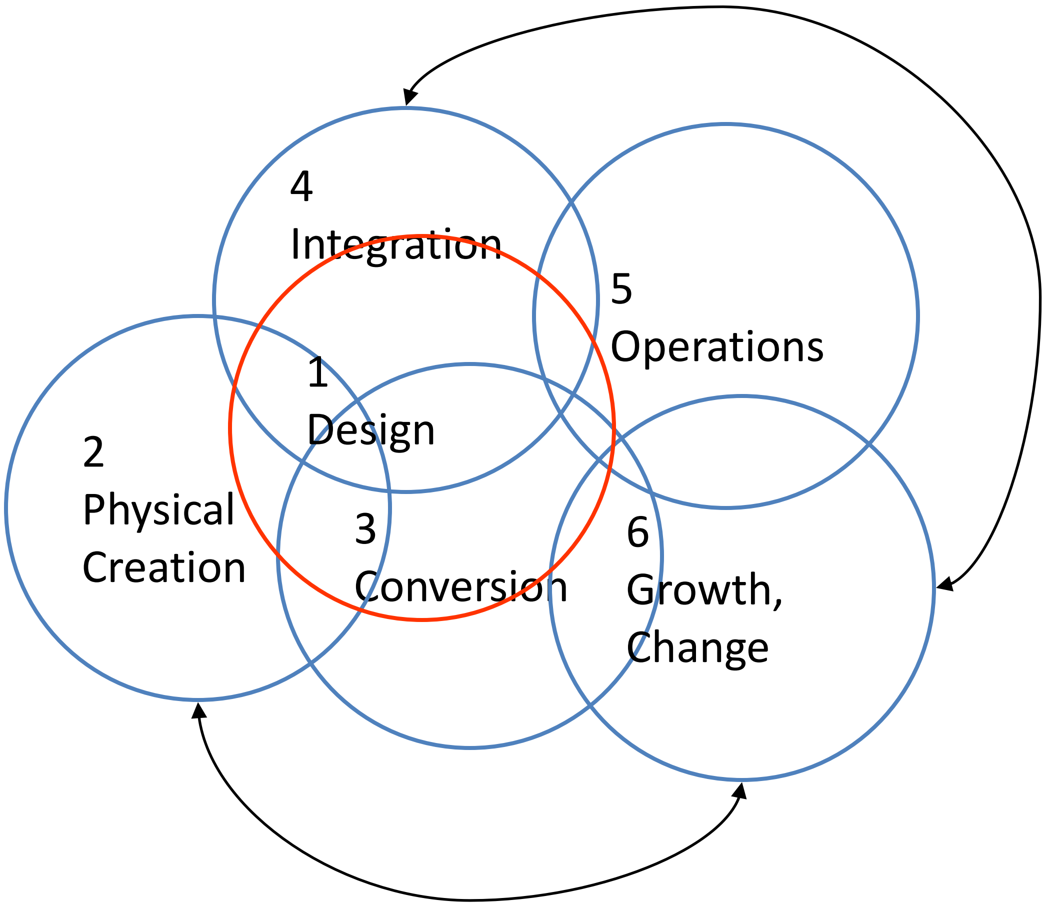
Operations

- All applications run full-scale
- Privacy, security, access control must be in place.
- Recovery and Backup procedures must be established and used

Growth, Change & Maintenance

- Change is a way of life
  - Applications, data requirements, reports, etc. will all change as new needs and requirements are found
  - The Database and applications and will need to be modified to meet the needs of changes

Another View of the Life Cycle



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